

WHAT IS CLAIMED IS:

1. A system for controlling laser power in a communication system, the system comprising:

a first node having a movable avalanche photodiode detector (APD) configured to convert an incoming communication beam in a photo current;

an amplifier configured to convert the photo current into a voltage signal;

a processing circuit configured to convert the voltage signal into a received signal strength indicator (RSSI);

a current sense module configured to measure a receive (Rx) power signal for the movable APD;

an actuator coupled to the first node and configured to move the APD;

an optical attenuator coupled to the first node and configured to attenuate an energy level of the incoming communication beam;

a processor configured to control the alignment of the movable APD with the incoming communication beam based on the RSSI and the Rx power signal and further configured to enable and disable the optical attenuator.

2. The system of Claim 1 further comprising:

a high voltage control (HVC) configured to adjust a variable voltage bias to the APD in response to a change in the photo current whereby an APD gain value is simultaneously adjusted, wherein the variable voltage bias is controlled by the processor using a high voltage control signal based on the Rx power signal measured by the current sense module; and

a high voltage supply configured to provide voltage to the HVC.

3. The system of Claim 1 further comprising:

a second node configured to transmit the incoming communication beam at a first power level to the first node and configured to receive an outgoing communication beam transmitted by the first node;

a first control module configured to control the first node to maintain a safe exposure level to a blocking object by changing a second power level of the outgoing

communication beam based on the first power level of the incoming communication beam; and

a second control module configured to maintain the safe exposure to the blocking object by changing the first power level of the incoming communication beam based on the second power level of the outgoing communication beam.

4. A system for calibrating an avalanche photodiode detector (APD) for use in an optical communication system, the system comprising:

a current sense module configured to measure a receive (Rx) power output value for an APD;

a high voltage control (HVC) configured to provide a variable voltage bias to the APD in accordance with a high voltage control signal;

a thermal sensor configured to measure a temperature of the APD;

a processor configured to provide the high voltage control signal to the HVC, wherein the high voltage control signal is based on the temperature and the Rx power output value; and

a high voltage supply configured to provide voltage to the HVC.

5. The system of Claim 4, wherein the current sense module includes a first series resistor located between the APD and the HVC and configured to measure a conduction value for the APD, and includes a first differential amplifier configured to amplify the measured conduction value and provide the Rx power output value to the processor.

6. The system of Claim 5, wherein the HVC includes a second series resistor and an electrical feedback loop, wherein the electrical feedback loop is configured to change the variable voltage bias to the APD in response to the high voltage control signal.

7. The system of Claim 6, wherein the electrical feedback loop includes a differential amplifier and a field effect transistor.

8. A system for increasing an operational dynamic range of an avalanche photodiode detector (APD) for use in an optical communication system, the system comprising:

a current sense module configured to measure an incoming photo current to an APD;

a high voltage control (HVC) configured to reduce a variable voltage bias to the APD in response to a decrease in the incoming photo current whereby an APD gain value is simultaneously decreased;

a processor configured to control the variable voltage bias using a high voltage control signal based on the incoming photo current measured by the current sense module; and

a high voltage supply configured to provide voltage to the HVC.

9. The system of Claim 8, wherein the current sense module includes a first series resistor located between the APD and the HVC.

10. The system of Claim 9, wherein the HVC includes a second series resistor and an electrical feedback loop, wherein the electrical feedback loop is configured to change the variable voltage bias to the APD in response to the high voltage control signal.

11. The system of Claim 10, wherein the electrical feedback loop includes a differential amplifier and a field effect transistor.

12. A method for calibrating an avalanche photodiode detector (APD) for use in an optical communication system, the method comprising:

turning off transmitted optical power incident on the APD to limit light from reaching the APD;

lowering a bias voltage for the APD to zero volts;

once lowered, measuring an initial conduction for the APD;

storing the initial conduction;

incrementally increasing the bias voltage until current is sensed through the APD;

once current is sensed, measuring a maximum bias voltage across the APD;

determining a calibration value based on the initial conduction and the maximum bias voltage; and

applying the calibration value to the APD.

13. The method of Claim 12, further comprising:

measuring a temperature of the APD; and

correcting the calibration value based on the measured temperature.

14. The method of Claim 12, wherein the maximum bias voltage is reduced by a predetermined amount.

15. A method for increasing an operational dynamic range of a variable gain avalanche photodiode detector (APD) for use in an optical communication system, the method comprising:

setting a voltage bias for an APD;

sensing a reduction in incoming photo current to the APD; and

reducing the voltage bias of the APD such that a gain value applied to the photo current is reduced, wherein an operational dynamic range of the APD is increased.

16. A method for controlling incoming laser power in a communication system which includes a first node and a second node where the second node transmits a first communication beam to the first node and where the first node includes a first optical attenuator, the method comprising:

monitoring the receive (Rx) power level of a photodiode detector in a first node;

determining if the Rx power level exceeds a saturation threshold level for the photodiode detector;

if the Rx power level exceeds the saturation threshold level of the photodiode detector, enabling a first optical attenuator that is located in a path between the first communication beam and the photodiode detector; and

if the Rx power level is below a minimum threshold level of the photodiode detector, disabling the first optical attenuator.

17. The method of Claim 15, wherein the first optical attenuator is configured to control the energy of the first communication beam as it passes through the first optical attenuator.

18. The method of Claim 16, wherein the first optical attenuator is configured as an electrochromatic window which changes its light transmission properties upon application of a voltage.

19. The method of Claim 16, wherein the first optical attenuator is configured as a light valve LCD iris.

20. The method of Claim 16, wherein the first optical attenuator is a photogrey type material which is configured to change its light transmission properties upon application of a sufficient amount of incident energy from the first communication beam.

21. The method of Claim 16, further comprising enabling a second optical attenuator that is located in the path between a second communication beam and the second node, wherein the second communication beam is a reflected signal from the first communication beam.

22. The method of Claim 16, wherein the first optical attenuator is configured to move out of the path of the first communication beam.

23. A system configured for controlling incoming laser power in a communication system which includes a first node and a second node where the second node transmits a communication beam to the first node, the system comprising:

- a first node having a photodiode detector configured to receive an incoming communication beam;

- a first optical attenuator coupled to the first node and configured to attenuate the incoming communication beam prior to it reaching the photodiode detector;

- a second node configured to transmit the incoming communication beam; and

- a first attenuation control module configured to control the first optical attenuator to maintain a power level of the incoming communication beam to within an operational range of the photodiode detector.

24. The system of Claim 23, wherein the first attenuation control is configured to disable and enable the first optical attenuator to keep the power level of the incoming communication beam to within the operational range of the photodiode detector.

25. The system of Claim 24, wherein the first attenuation control is configured to move the first optical attenuator into and out of a path of the incoming communication beam.

26. The system of Claim 24, wherein the first optical attenuator is configured as an electrochromatic window which changes its light transmission properties upon application of a voltage by the attenuation control.

27. The system of Claim 24, wherein the first optical attenuator is configured as a light valve LCD iris.

28. The system of Claim 24, wherein the first optical attenuator is a photogrey type material which is configured to change its light transmission properties upon application of a sufficient amount of incident energy from the incoming communication beam.

29. The system of Claim 24, further comprising a second optical attenuator that is located between an outgoing communication beam and the first node, wherein the outgoing communication beam is a reflected signal from the incoming communication beam.

30. A system for aligning an optical receiver to an incoming communication beam for use in an optical communication system, the system comprising:

- an avalanche photodiode detector (APD) configured to convert a communication beam into a photo current;

- an amplifier configured to convert the photo current into a voltage signal;

- a processing circuit configured to convert the voltage signal into a received signal strength indicator (RSSI);

- a current sense module configured to measure a receive (Rx) power signal for the APD;

- an actuator configured to align the APD with the communication beam; and

- a processor configured to control the actuator based on a combined power signal which includes the RSSI and the Rx power signal.

31. The system of Claim 30, wherein the Rx power signal measures conduction through the APD.

32. The system of Claim 30, wherein the processor is further configured to determine the RSSI based on an empirically determined relationship of signal strength to incident angle of the communication beam, and is derived from characterization of behavior of the optical communication system.

33. The system of Claim 30, wherein the processor is further configured to determine the Rx power signal based on an empirically determined relationship of signal strength to incident angle of the communication beam, and is derived from characterization of the behavior of the optical communication system.

34. The system of Claim 30, wherein the processor is further configured to determine the combined power signal based on a weighted sum of components including the Rx power signal and the RSSI.

35. The system of Claim 32, wherein the RSSI signal ($P_{RSSI}(x)$) is calculated from

$P_{RSSI}(9980) = 6 \cdot 10^4$, where x is an incident angle in the range from 9920 to 10000.

36. The system of Claim 33, wherein the Rx power signal ($P_{Rx}(x)$) is calculated from

37. The system of Claim 34, wherein the combined power signal ($P_{combined}(x)$) is calculated from

38. The system of Claim 37, wherein the processor maximizes the combined power signal.

39. A method for aligning an optical receiver to an incoming communication beam for use in an optical communication system, wherein the optical communication system includes a first node and a second node, each including a movable avalanche photodiode detector (APD) configured to receive a communication beam from the other node, the method comprising:

converting an incoming communication beam to an APD into a photo current;

converting the photo current into a voltage signal;

determining a received signal strength indicator (RSSI) from the voltage signal;

determining a receive (Rx) power signal for the APD;

aligning the APD with the communication beam based on the RSSI and the Rx power signal.

40. The method of Claim 39, wherein determining the RSSI includes empirically determining a relationship of signal strength to incident angle of the incoming communication beam that is derived from characterization of behavior of the optical communication system.

41. The method of Claim 39, wherein determining the Rx power signal includes empirically determining a relationship of signal strength to incident angle of the incoming communication beam that is derived from characterization of behavior of the optical communication system.

42. The method of Claim 39, further comprising combining the RSSI and the Rx power signal based on a weighted sum of components that includes the Rx power signal and the RSSI.

43. The method of Claim 40, wherein determining the RSSI signal ($P_{RSSI}(x)$) is calculated from

$P_{RSSI}(9980) = 6 \cdot 10^4$, where x is an incident angle in the range from 9920 to 10000.

44. The method of Claim 41, wherein determining the Rx power signal ($P_{Rx}(x)$) is calculated from

45. The method of Claim 42, wherein aligning the APD includes maximizing a combined power signal ($P_{combined}(x)$) which includes the RSSI and the Rx power signal using equation